

He rejects Schimper's view that the cluster of gemmæ in *Georgia* and *Edipodium* is homologous with a male "flower," the gemmæ being sterilized antheridia; and also dismisses as improbable Brefeld's suggestion that they are sterile sporangia, like chlamydospores.

The structure and development of the brood-bodies, their separation, distribution, mode and conditions of germination, and the conditions for their formation are described. Finally the author furnishes a key to the various kinds of brood organs and the species in which they occur.

A list of the literature, which consists mainly of the [systematic works referred to, the special literature being very scanty, and an inadequate index complete the work.

The interest and value of the book lie in the exhaustive treatment of a subject, presumably narrow, which has shown itself broad when thoroughly studied. It would be interesting to have a similar study of the vegetative reproduction among the *Hepaticæ*, and we trust Dr. Correns will include in this thorough investigation both classes of the *Bryophyta*.—C. R. B.

### NOTES FOR STUDENTS

VÖCHTING, the author of the well-known work on Transplantation and of various papers having to do with the correlations of organs and tissues, has published the results of some extended investigations on tuberous plants.<sup>4</sup> It is essentially, as he terms it, a study of the vicarious organs of these plants, and is a continuation and extension of a line of work begun long ago. The power of one organ to perform the function of another in case of need has long been known, and many instances of this phenomenon have been summarized by Hertwig among animals and by Goebel and Vöchting among plants. As long ago as 1803 Knight grafted the stem of a grape vine upon a petiole, and the latter organ developed woody tissue as a result. The author himself showed in previous studies that a potato tuber may be inserted into the stem and caused to develop mechanical and conductive tissues, and that the suppression of the tubers of the artichoke is followed by a swelling of other organs to take their place. In the above cases the replacing organ is essentially the same in kind as that replaced, but Vöchting now shows that almost any organ, if properly stimulated, may become a tuber. He defines a tuber as a fleshy body used for storage, whether morphologically stem, root, or leaf—a definition that the following results obviously require.

The experiments upon vicarious organs arrange themselves into two groups: a tuber may replace a stem when put in such a position that its normal function cannot be performed, or a tuber may be developed from almost any organ if the normal formation of tubers is suppressed. One of the most plastic plants studied was *Oxalis crassicaulis*, a plant which normally

<sup>4</sup> Prings. Jahrb. für wiss. Bot. 34: 1-148. 1899.



resembles the potato in the development of subterranean stem tubers. A tuber placed in an erect position, partially below the soil line and partially above it, develops roots and rhizomes from the buried portions and green shoots from the aerial portions. Instead of decaying rapidly, as a tuber commonly does when it has disposed of its stock of reserve food materials, the *Oxalis* tuber, placed in this abnormal position, lives and grows through the entire season. The tuber is obliged to function as a stem, both in the conduction of water and the plastic foodstuffs and in giving mechanical support to the aerial organs. As a result of these new functions, the author finds a striking change in the anatomy of the tuber. Instead of the predominance of parenchymatous storage cells, there is a great increase in the area of the vascular bundles; the secondary phloem and xylem develop remarkably, and the new cells and cell fusions have a much larger cross section and more complicated structures. The strong development of bast fibers and wood cells materially adds to the mechanical strength of the tuber in its new relations. Thus the tuber has become like a normal stem in structure as in function.

The suppression of normal tuber formation in *Oxalis* stimulates their development in a new position. The plant sometimes develops stolons whose ends bury in the soil and develop tubers from the terminal bud. If this bud is removed, the bud nearest the end becomes a tuber, and if all the buds are removed one of the stolon internodes swells up like a tuber. In some cases the leaves instead of the internodes become tubers, and the leaflets may remain as rudiments or may swell up like the petiole. The structure of the petiole which functions as a tuber undergoes a remarkable change. The ventral furrow is absent, the petiole being round in cross section. There is no collenchyma, or green tissue, and the bundles which are so prominent in a normal petiole remain in a rudimentary condition; even the vessels which are present may be filled up with tyloses. The changed petiole is almost wholly made up of storage parenchyma. The starch grains here often assume the most fantastic shapes; indeed Vöchting commonly finds that the more abnormal the organ which becomes a tuber, the more abnormal are the starch grains, indicating an intimate correlation of structures of a surprising nature.

Experiments similar to those just mentioned were performed on the potato but were less successful as a rule, showing, the author thinks, that *Solanum* is less plastic and that the metamorphosis of stem to tuber has gone further than in *Oxalis*. A root of *Dahlia variabilis* was planted somewhat emerging from the soil. The new roots, which commonly form in a cluster at the base of the stem, formed at the base of the parent root, since the base of the stem was in the light. The next year the compound root system was planted with these new roots emerging from the soil, and new roots formed at the base of this second story of roots. This process was repeated until



finally four tiers of roots were developed. Each year the plant started later and later, and for a long time the leaves remained yellow, showing the difficulty the plants had in conducting materials up through the series of root tubers. The fifth year the struggle was too severe, and the plant died. These tubers did not develop buds and were hence incapable of propagating the species, but experiments showed that decapitated budless tubers can remain alive and fresh for several years. The Dahlia tubers developed a stem structure like those of *Oxalis*.

One of the most plastic plants employed was *Boussingaultia baselloides*, a plant with the potato type of tuber. This plant grows readily from cuttings, roots and rhizomes springing from the subterranean buds, and green shoots from the aerial buds. When cuttings are placed in the soil so that all buds are in the light, the base of the stem itself, *i. e.*, the buried internode, swells up into a tuber; if the base of the internode lies deep, the tuber is elongated, if shallow, it is shortened, showing the restricting influences of light in tuber formation. As in Dahlia, these tubers are budless and remain fresh and living for a year or two, but cannot propagate the species. The change in structure is similar to that in the *Oxalis* petiole which becomes a tuber. A leaf of *Boussingaultia* when placed in the soil gives off roots, one of which swells into a budless tuber; these tubers live and function if a shoot is grafted upon them. (Leaves of *Gloxinia* root similarly but develop buds and are capable of growth.) The experiments on this plant and on *Oxalis* seem to show a strong inclination toward tuber formation, an inclination which must be satisfied in one way if not in another. In *Thladiantha dubia*, a tuberous member of the melon family, the author succeeded in setting out a tendril and developing a starchy tuber from its base, which remained fresh long after the tendril died.

Vöchting carried on several experiments for the purpose of showing the influence of external factors, especially light and darkness, upon tuber formation. The restricting influence of light in the case of Dahlia and *Boussingaultia* has already been indicated. In the radish the tuber is partly root but mostly hypocotyl. Plants with all the hypocotyl and part of the root above the soil tended to develop elongated tubes, to which the root contributed half or more; in some cases all of the tuber was developed from the root. Etiolated seedlings were darkened at various points by tinfoil, and tuberous swellings appeared within the darkened areas, but always as near the top as possible. Two or three separate tubers were sometimes developed in this way on a single plant. Low temperature and drought were shown to facilitate tuber formation in *Oxalis*, but the internal forces are so strong that they are not effective early in the season, nor, on the other hand, will warmth and moisture greatly retard tuber formation in the fall. In this species also light is unable to prevent finally tuber formation, though it greatly retards it. The



strong tendency to tuber formation which finally overcomes all obstacles is due, the author thinks, not only to the internal force which looks to the propagation of the species, but also to a demand for organic symmetry; the occasional development of potato tubers without starch, and therefore functionally impotent, appears to favor this conclusion.

The author has thus been enabled to establish upon a firmer basis than ever before his ideas as to the great plasticity of plants and the vicarious nature of their organs. Perhaps the most astounding thing of all is the power shown by a mature organ, like the tuber of *Oxalis* or *Dahlia*, to be born again, as it were, and start on a period of secondary growth. The plasticity of a young organ is well known, and perhaps not so surprising, but one would scarcely have expected to see such evidences of life and vigor in a specialized organ like a tuber.—HENRY C. COWLES.

THE ORIGIN of the cilia of the spermatozoid is very briefly but clearly traced by Belajeff<sup>5</sup> in *Gymnogramme sulphurea* and *Equisetum arvense*. In *Gymnogramme* two centrosomes (the blepharoplasts of Webber and others) make their appearance at opposite poles of the nucleus of the grandmother cell of the spermatozoid. The division of this nucleus is not accompanied by a division of the centrosome, and consequently each of the resulting cells receives only a single centrosome. The centrosome, originally spherical, elongates into a narrow band lying alongside the nucleus, and the cilia arise from the peripheral portion of the band.

The sequence is the same in *Equisetum*, but here the writer was able to show that the band is made up of a row of intensely staining granules and a less deeply staining portion. Each granule gives rise to a single cilium.

The spherical organs which give rise to the band are regarded as genuine centrosomes, and Belajeff would homologize with them the blepharoplasts of Webber (*Zamia*) and Shaw (*Marsilea* and *Onoclea*), and also with the cilia-forming centrosomes of Hirase (*Gingko*) and Ikeno (*Cycas*). He would also homologize the cilia-forming band with the "middle piece" of the animal spermatozoon, as described by Hermann for the salamander.—CHARLES J. CHAMBERLAIN.

IN A STUDY of the influence of weather and the condition of the soil upon the anatomical structure of plants, W. Meyer<sup>6</sup> objects to culture experiments and goes for his material to nature, where plants may be found under the same conditions for many generations. He compares numerous members of the Caryophyllaceæ, chiefly alpine forms, and shows how species in different divisions of the same family have a close resemblance to one another when growing in similar situations. For example, species of the *Sileneæ*, *Alsineæ*,

<sup>5</sup> Ueber die Cilienbildner in den spermatogenen Zellen. Ber. d. deutsch. bot. Gesell 16:140-144. pl. 7. 1898.

<sup>6</sup> Bot. Centralb. 79: 337-350. 1899.



and Paronychieæ growing in deserts resemble each other and also those on alpine heights, for in high altitudes the sun's rays are very powerful and plants need the same protection as in deserts. On the other hand, specimens of the same species, under various conditions, show extreme divergence. He also shows that many species of the Primulaceæ resemble those of the Caryophyllaceæ when grown under like conditions. Only a causal dependence between situation and structure can explain such resemblance, since common origin cannot do it. — L. M. SNOW.

SEEDS whose viability had been previously tested by samples were recently submitted by Professor Dewar to the intense cold of liquid hydrogen, *i. e.*,  $-250^{\circ}$  C. for half an hour. Some of the seeds were cooled in a sealed glass tube, and others were immersed without protection in the liquid hydrogen. All the seeds in both sets germinated. — C. R. B.

THE LITERATURE of diatoms has recently been enriched by a very important contribution.<sup>7</sup> The work is not merely a guide for the determination of the species of a limited locality, but is a comprehensive text-book of diatom lore. The author has departed from the usual comparatively superficial methods, and has taken into account the form and structure of the protoplast, the position of the nucleus, the number, form, and position of the chromatophores, the occurrence of pyrenoids, and, finally—a most important consideration—the complete life history of each species as far as this has been possible. A study of cell characters convinced the author that the number and position of chromatophores is the most important taxonomic character, and that mere frustule characters are not sufficient for determining the limits of species.

The second part of the work gives a somewhat extended account of the diatom cell, cell division, movements of diatoms, the relation of variety of form to environmental factors, the auxospores, and the rôle of diatoms in the economy of nature. — CHARLES J. CHAMBERLAIN.

THE PRODUCTION of apospory by environment has been brought about in various ferns. Mr. F. W. Stansfield<sup>8</sup> has succeeded in producing apospory in *Athyrium filix-fœmina*, *unco-glomeratum*, an apparently barren form. In all cases it was noted that prothalli are produced with much more ease from young fronds than from adult ones. If the first fronds from a prothallus are pinned down, the edges rapidly develop into prothalli. The aposporous production of prothalli is regarded as an atavistic trait, and the suggestion is made that apospory could be produced in many ferns by taking sufficient

<sup>7</sup>KARSTEN, GEORGE; Die Diatomeen von Kieler Bucht. Wissenschaftliche Meeresuntersuchungen herausgegeben von der Commission zur Untersuchung der deutschen Meere in Kiel und der biologischen Anstalt auf Helgoland. Abtheilung Kiel. Neue Folge 4: 19-295. *figs.* 219. 1899.

<sup>8</sup>Jour. Linn. Soc. Bot. 34: 262-268. 1899.



care. The fact that Mr. Druery, a few years ago, succeeded in producing apospory in *Scolopendrium vulgare*, presumably a most unlikely form for such an experiment on account of the smooth strap-shaped leaves, indicates that the suggestion has some weight.—CHARLES J. CHAMBERLAIN.

APPLE CANKER, which attacks the bark of the limbs of apple trees of all ages, has been traced by Mr. W. Paddock,<sup>9</sup> of Geneva, N. Y., to the well-known *Sphæroopsis malorum* Pk., causing the black rot of apples. Cultures have been made on sterilized bean stems, and the disease produced by inoculation. In a later communication<sup>10</sup> further observations are given upon the destructiveness of the disease, which occurs, as it is discovered, in pears and quinces as well as in apples. Trees may be entirely killed by this disease, which in most cases progresses from the smaller branches toward the trunk.—J. C. A.

WEEDS have been the subject of a number of bulletins from the agricultural experiment stations, not yet mentioned in these pages. Only the western states are represented. F. H. Hillman (Nev. no. 38: 1-131. 127 cuts in text) describes the seeds of many weeds with much clearness and detail, and presents one hundred and twenty five cuts, drawn by himself, illustrating as many kinds of seeds. These illustrations are worthy of special commendation for their accuracy and artistic merit, and also because they are well printed. L. F. Henderson (Idaho no. 14: 91-136. 13 pl. and 5 cuts in text) discusses twelve of the state's worst weeds, and says good things about the value and justice of weed laws. E. E. Bogue (Oklahoma no. 41: 1-12. 14 cuts in text) presents information regarding seventeen weeds, of which those least known eastward are *Solanum Torreyi*, *Acacia filiculoides* and *Croton Texensis*. A. S. Hitchcock and G. L. Clothier have issued a press bulletin (no. 18) of two pages giving notes on weeds, and also a sixth report on Kansas weeds (Kans. no. 80: 113-164). A large fund of information is presented regarding the habits and distribution of weeds, not only of Kansas, but of the whole United States. Charts are used to show the distribution by counties in Kansas of 209 species, and by states in the whole country of 194 species. L. H. Pammel presents a full account (Iowa no. 38: 7-24. 7 cuts in text) of the Russian thistle, with a bibliography; also a discussion of the weeds of cornfields (Iowa no. 39: 27-52. 17 cuts in text), and of horse nettle (*Solanum Carolinense*), *Convolvulus arvensis* and *Tribulus terrestris* (Iowa, no. 42: 130-140. 5 cuts in text), the last species having recently gained a foothold on Muscatine island in the Mississippi river. E. S. Goff (Wis. no. 76: 1-53. 39 cuts in text) gives illustrations and information regarding the ten weeds mentioned in the Wisconsin weed law, with notes on eight others.—J. C. A.

<sup>9</sup> *Science* 8: 595.

<sup>10</sup> *Science* 8: 836.



THE RUST FLORA of California, according to E. W. D. Holway in the October *Erythea*, embraces 122 species of Puccinia, 42 of Uromyces, and 73 of other genera.—J. C. A.

ANOTHER ARTICLE<sup>11</sup> has recently been added to the valuable series of physiological papers already so auspiciously inaugurated by Dr. Klebs. The same ingenious accurate experimentation which characterized the earlier papers of the series is evident. The presentation is masterly. The purpose of the research is to determine the chemical and physical factors which incite or alter the various modes of reproduction in *Saprolegnia mixta*. It is found that this species will grow indefinitely without either sexual or asexual reproduction if nourishment be abundant; but at any time the extensive formation of zoospores can be incited by simply starving the hyphæ, *e. g.*, by placing them in water. By noting the maximum concentration at which various foods induce the formation of zoospores an idea was obtained as to their relative food value. Albumens are rich; amido-acids can furnish C as well as N; in general the food value rises with the carbon content; glucosides vary from toxic to indifferent or even favorable; inorganic acids and their salts are of but little value.

By varying the nutritive value of any medium the fungus can be made at will to assume a purely vegetative condition; to produce rudimentary sporangia; to form sporangia which bear zoospores that do not escape; and to produce functional zoospores. All of these phenomena depend for their existence upon the concentration of the medium, not upon the total quantity of nutriment.

It happens, however, that even in strong solutions the formation of zoospores is often eventually suppressed. This led Dr. Klebs to infer the presence of an inhibiting agent formed in the medium by the growth of the fungus. One such substance he finds is ammonium carbonate. If the medium be rendered weakly acid zoospore formation can be resumed. Starvation, if very gradual, causes the mycelium to become too weak to build zoospores. Poisons inhibit their formation as does also high osmotic pressure. Experiments show very clearly what are the necessary relations and also the responses, but the reasons for both are totally obscure. Zoospores are never found unless the tips of the hyphæ are in contact with water. Oxygen, light, and heat are of little importance.

If a well nourished mycelium be placed in a poor medium where the conditions render the formation of zoospores impossible, *e. g.*, in a solid medium, sexual organs will soon appear in abundance. These, however, are sensitive to heat (their maximum being 26°, that of sporangia 32°) and fastidious as to

<sup>11</sup> Zur Physiologie der Fortpflanzung einiger Pilze: Jahr. f. wiss. Bot. 33: 71. 1899. Reviews of earlier papers may be found in this journal 23: 214. 1893, and 27: 77. 1899.



their inorganic food, seeming quite dependent upon the presence of some form of potassium phosphate. This is particularly true of antheridia, and by varying the medium a filament may be obtained which bears no sex organs, or one bearing only oogonia, or one with oogonia and a few antheridia, or, finally, one with many antheridia some of which form fertilizing tubes. In this connection it should be recalled that specific distinctions have been based on the abundance of antheridia. In general the relation between oogonia and antheridia is such that support is given to the view of DeBary, viz., that the presence of oogonia induces the formation of antheridia. Dr. Klebs thinks this is due either to chemotaxis when proper inorganic salts are present, or that these salts render the twigs sensitive to the chemical stimulus emanating from the oogonia. It is evident, however, that normal oogonia can exist without inducing antheridial formation.

While as conclusively proved in this research, there is no dominating inherent tendency toward an alternation of generations, nevertheless the conditions are such that in nature an alternation is usually brought about through the exhaustion of the nutriment afforded by each newly attacked host.

Previous to oosphere formation the incipient oogonium may revert to a vegetative condition, but after the oospheres are differentiated the power to vegetate is irretrievably lost. This, the author thinks, is due to nuclear changes possibly to a chromosome reduction.

An interesting chapter is given to the consideration of gemmæ and the author concludes, apparently with ample ground, that they are of no significance in phylogeny. They are special structures whose function is to tide over times when the formation of other spores is precluded. They behave in general as do hyphæ, and develop into oogonia or sporangia according to environment. Dr. Klebs closes by saying that an acquaintance with mere morphological marks does not constitute sufficient knowledge of a species. To meet his high ideal the systematist must hereafter determine, both quantitatively and qualitatively, the life relations of the plant, its limits of variation, and the stimuli that cause these variations.—F. L. STEVENS.

WHETHER THE Saprolegniaceæ are exclusively apogamous or not is a question that has been argued *pro* and *con* in pre-cytological days by DeBary, Pringsheim, Cornu, Zopf, Ward, Humphrey, and others. Four years ago Messrs. Hartog and Trow almost simultaneously published papers expressing quite opposite views regarding fertilization in this group. Trow has recently made extended researches on *Achlya*<sup>12</sup> and arrives at conclusions in harmony with his earlier paper. He describes a karyokinetic division of the oogonial nuclei and a degeneration or digestion of the supernumerary ones, so that only

<sup>12</sup> Trow, A. H.: Observations on the biology and cytology of a new variety of *Achlya Americana*. *Ann. Bot.* 13: 131.



one remains to function in each oosphere. Trow is convinced that true fertilization, a fusion of sexual nuclei, does occur. It is to be regretted, however, that his technique was not improved to such a point of efficiency as to insure more unequivocal evidence than he presents. The final impression that is left with the critical reader is that Trow has seen some things which make a fertilization seem possible, or even probable; but that it is far from being proved. A really valuable feature of Trow's work consists in the observations on live material, by which he has followed the growth of the organism from the zoospore to complete maturity, including development, ripening, and germination of the oospores.

An article which bristles with caustic but mainly petty criticism regarding Trow's conclusions and theories appears in the September *Annals of Botany*.<sup>13</sup> This criticism, like Hartog's criticism of Trow's earlier paper, while it increases the literature by several pages, sheds no light on the perplexing questions.—F. L. STEVENS.

<sup>13</sup> HARTOG, MARCUS: The alleged fertilization in the Saprolegniaceæ. *Ann. Bot.* 13: 447.